

CLAIMS

What is claimed is:

5 1. A method for determining an exponential decay rate of a signal in the presence of noise, said method comprising:

receiving an exponentially decaying signal from a detector;

10 digitizing said signal to form a first array of data points;

estimating a baseline value of said signal by averaging a final fraction of said data points;

subtracting said baseline value from said first array to generate a second array;

15 identifying a last data point on said second array occurring before a negative or nil valued data point on said second array;

20 scaling an ordinate value of said last data point by a factor greater than unity to determine a new first data point for a baseline fit on said first array;

fitting remaining data on said first array to a straight line to determine an estimate for a sloping baseline and said noise;

25 subtracting said straight line from said data points to establish a resulting array;

identifying a last data point on said resulting array occurring before a negative or nil valued data point on said resulting array;

30 performing a logarithmic transformation of said resulting array up to said last data point on said resulting array; and

determining said decay rate of said signal.

2. The method of claim 1 wherein said determining step includes determining said decay rate of said signal by a weighted least squares fit to said transformed data.

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3. The method of claim 2 wherein said weighted least squares fit includes weighting each transformed data point inversely proportional to a square of said value of said digitized signal minus said estimated baseline value.

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4. The method of claim 1 wherein said signal is generated in a ring-down cell.

5. The method of claim 4 wherein said ring-down cell

15 includes two or more mirrors in any geometry that produces a stable optical cavity.

6. The method of claim 1 wherein said detector includes a photodector.

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7. The method of claim 1 further comprising removing transient points from said first array.

8. The method of claim 1 wherein said subtracting a

25 baseline value includes subtracting a DC level.

9. The method of claim 7 wherein said subtracting a baseline value includes subtracting a DC level.

30 10. The method of claim 1 wherein said noise includes broadband noise and excess low frequency noise.

11. The method of claim 10 wherein said low frequency noise has spectral components having a period greater than four times a record length.

5 12. The method of claim 4 further comprising energizing said ring-down cell.

13. The method of claim 12 wherein said energizing step includes utilizing a laser.

10 14. The method of claim 13 wherein said laser is a continuous wave laser.

15 15. The method of claim 13 wherein said laser is a pulsed laser.

16. A ring-down cavity system for determining an exponential decay rate of a signal in the presence of noise comprising:

20 a ring-down cavity;
 a light source for injecting light into said cavity;
 a detector;
 a digitizer; and
 a processor for determining said decay rate by fitting a straight line to a curve associated with said decay rate at a time greater than where a negative or nil value is detected, removing undesirable data associated with said noise and logarithmically transforming said data.

25 30 17. The system of claim 16 wherein said light source is a laser.

- F D E C T O R S P E C I F I C
18. The system of claim 17 wherein said laser is a pulsed laser.
19. The system of claim 17 wherein said laser is a
5 continuous wave laser.
20. The system of claim 16 wherein said dectector is a photodectector.
- 10 21. The system of claim 16 wherein said processor for determining said decay rate further includes removing an estimated value of said noise from said signal.
- 15 22. A method for processing a data record to determine an associated decay rate of a species in the presence of noise, said method comprises:
- subtracting a DC offset from said data record;
- determining a time associated with a first data point occurring before a first negative or nil data point of said
20 data record;
- scaling said time by a factor greater than unity to determine an end time associated with a portion of said data record, said end time having a corresponding value;
- averaging data points from said time value to the end
25 of record;
- subtracting said value from each data point from said data record to create a new data record;
- determining an end point for said new data record associated with a first data point before a first negative
30 or nil data point of said new data record;
- logarithmically transforming said new data record; and

determining a decay rate from said logarithmic transform.

23. A method of measuring the decay rate of a signal having
5 noise, said method comprising:

measuring a data signal having noise;

forming a data array having data values associated with
said signal;

subtracting undesirable data values from said array;

10 establishing a resulting array;

testing said resulting array for a first negative or
nil value;

forming a new array ending at one value before said
first negative or nil value;

15 performing a logarithmic transformation on said new
array; and

determining said decay rate from said logarithmic
transformation.

20 24. A method for determining an exponential decay rate of a
signal in the presence of noise, said method comprising:

receiving an exponentially decaying signal;

digitizing said signal;

removing an estimated noise value from said signal;

25 identifying a cutoff point associated with said signal;
scaling said cutoff point by a factor greater than
unity;

determining a new estimated noise value;

removing said new estimated noise value from said
30 signal;

identifying a last point of said signal before a negative or nil valued data point on said resulting array; and

5 performing a logarithmic transformation to determine
said decay rate of said signal.